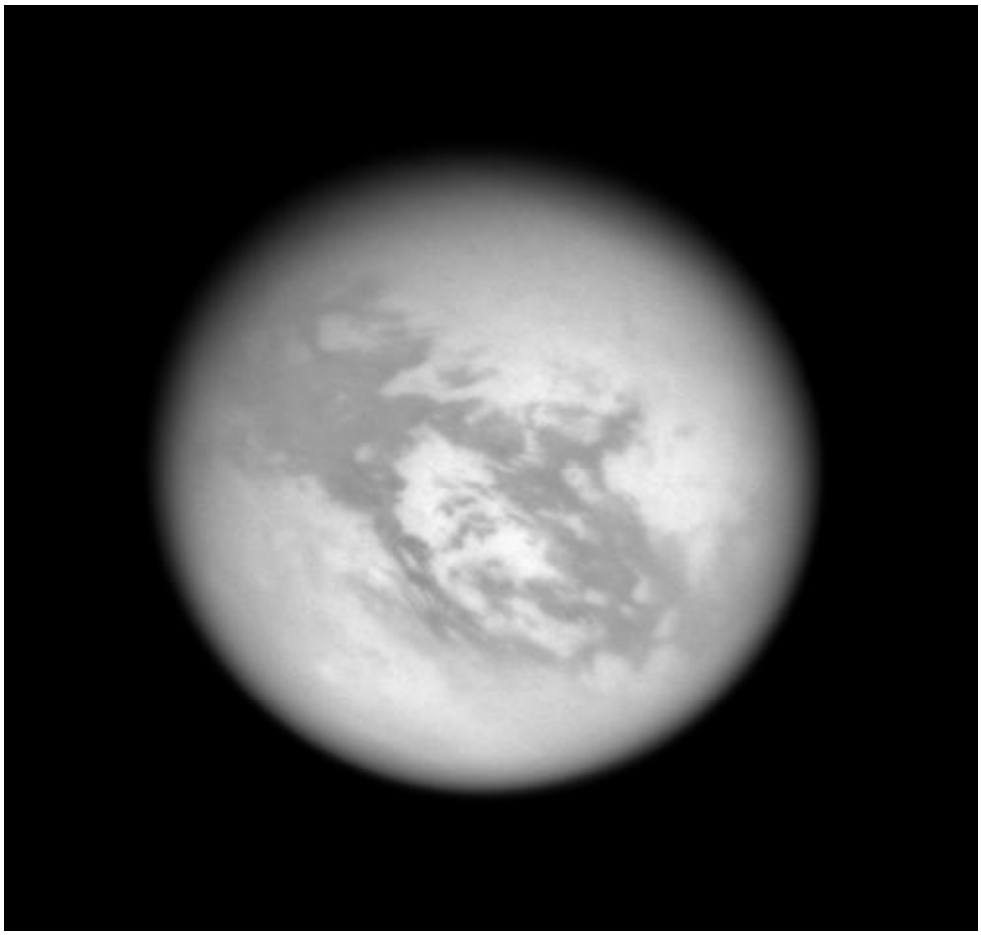
C A S S I N I



T I T A N **0 4 9 T I (T 3 5)** MISSION DESCRIPTION

August 2007

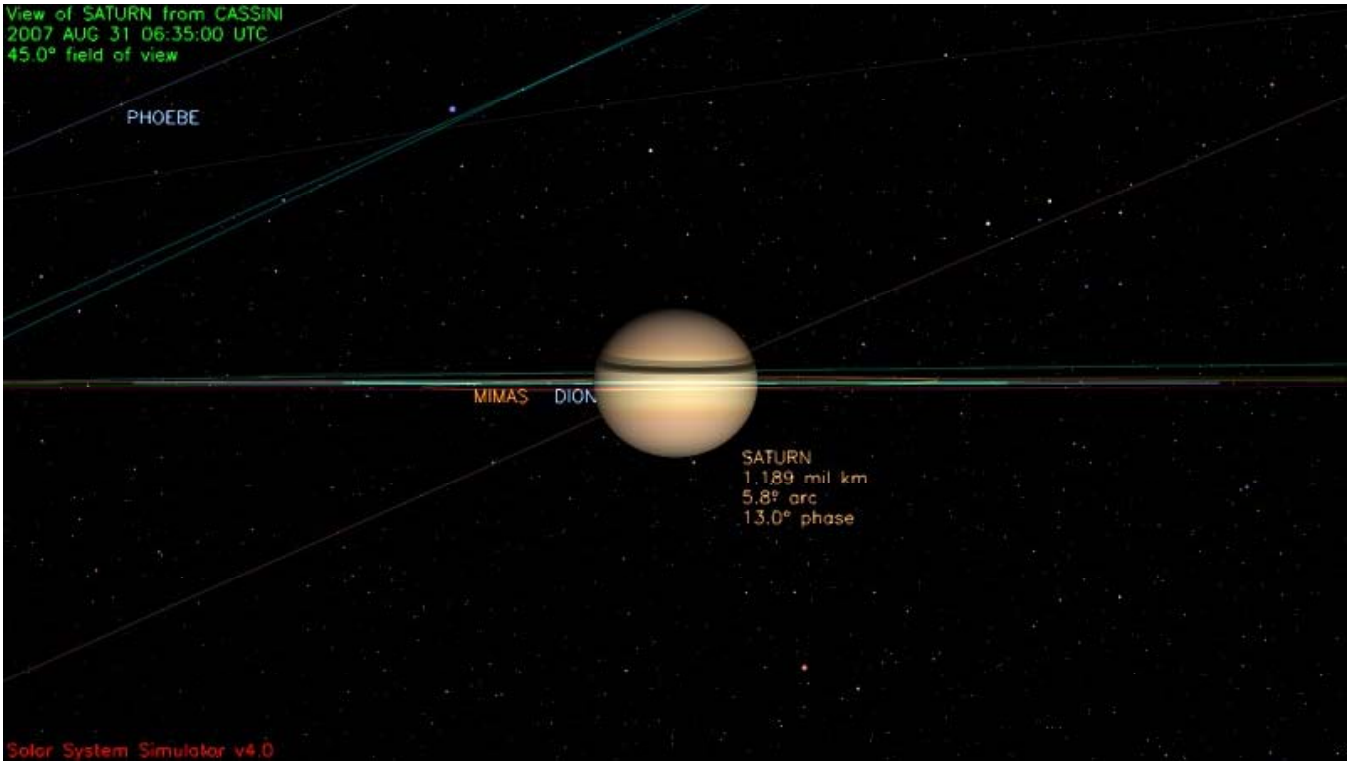
Jet Propulsion Laboratory
California Institute of Technology

Cover image:Above Adiri (July 31, 2007). Within the windswept wastes of Titan's equatorial dune desert lies the 1,700-km (1,050-mi) wide bright region called Adiri, seen here at center. The intrepid Huygens probe landed off the northeastern edge of Adiri in January 2005. This view looks toward the anti-Saturn side of Titan (5,150 kilometers, or 3,200 miles across) -- the side that always faces away from Saturn as the moon orbits. North on Titan is up and rotated 26 degrees to the right. The image was taken using a spectral filter sensitive to wavelengths of infrared light centered at 939 nanometers. The view was acquired with the Cassini spacecraft wide-angle camera on June 14, 2007 at a distance of approximately 157,000 kilometers (98,000 miles) from Titan. Image scale is 9 kilometers (6 miles) per pixel. Credits: NASA/JPL/Space Science Institute

1.0 OVERVIEW

Forty-three days after Cassini's Titan-34 flyby, the spacecraft comes back to Titan for its thirty-sixth targeted encounter. The closest approach to Titan occurs on Friday, August 31, at 2007-243T06:32:34 spacecraft time at an altitude of 3326 kilometers (~2070 miles) above the surface and at a speed of 6.1 kilometers per second (13,650 mph). The latitude at closest approach is 63.5 degrees N and the encounter occurs on orbit number 49.

This encounter is set up with two maneuvers: an apoapsis maneuver on August 5, and a Titan approach maneuver, scheduled for August 27. T35 kicks off a series of outbound encounters that will last until the end of the prime mission, and occurs less than two days before Saturn closest approach.



ABOUT TITAN

If Titan were a planet, it would likely stand out as the most important planet in the solar system for humans to explore. Titan, the size of a terrestrial planet, has a dense atmosphere of nitrogen and methane and a surface covered with organic material. It is Titan that is arguably Earth's sister world and the Cassini-Huygens mission considers Titan among its highest priorities.

Although it is far colder and lacks liquid water, the chemical composition of Titan's atmosphere resembles that of early Earth. This, along with the organic chemistry that takes place in Titan's atmosphere, prompts scientists to believe that Titan could provide a laboratory for seeking insight into the origins of life on Earth. Data from the Huygens probe, which touched down on Titan's surface in January 2005, and the Cassini orbiter has shown that many of the processes that occur on Earth also apparently take place on Titan – wind, rain, volcanism, tectonic activity, as well as river channels, and drainage patterns all seem to contribute in shaping Titan's surface. However, at an inhospitable -290 degrees Fahrenheit (-179 degrees Celsius), the chemistry that drives these processes is fundamentally different from Earth's. For example it is methane that performs many of the same functions on Titan that water does on Earth.

The Huygens probe landed near a bright region now called Adiri, and photographed light hills with dark river beds that empty into a dark plain. It was believed that this dark plain could be a lake or at least a muddy material, but it is now known that Huygens landed in the dark region, and it is solid. Scientists believe it only rains occasionally on Titan, but the rains are extremely fierce when they come.

Only a small number of impact craters have been discovered. This suggests that Titan's surface is constantly being resurfaced by a fluid mixture of water and possibly ammonia, believed to be expelled from volcanoes and hot springs. Some surface features, such as lobate flows, appear to be volcanic structures. Volcanism is now believed to be a significant source of methane in Titan's atmosphere. However, there are no oceans of hydrocarbons as previously hypothesized. Dunes cover large areas of the surface.

The existence of oceans or lakes of liquid methane on Saturn's moon Titan was predicted more than 20 years ago. Radar and imaging data from Titan flybys have provided convincing evidence for large bodies of liquid. With Titan's colder temperatures and hydrocarbon-rich atmosphere, these lakes and seas most likely contain a combination of liquid methane and ethane (both hydrocarbons), not water.

The Cassini-Huygens mission, using wavelengths ranging from ultraviolet to radio, is methodically and consistently revealing Titan and answering long-held questions regarding Titan's interior, surface, atmosphere, and the complex interaction with Saturn's magnetosphere. While many pieces of the puzzle are yet to be found, with each Titan flyby comes a new data set that furthers our understanding of this world as we attempt to constrain scenarios for the formation and evolution of Titan and its atmosphere.

1.1 TITAN-35 SCIENCE HIGHLIGHTS

- **VIMS** will attempt to understand the nature of Titan's North polar region and detect possible time-variable phenomena. The observations starting at 37 minutes before closest approach include a stellar occultation that will provide information on the structure and composition of the atmosphere, the development and evolution of clouds, and characterization of the haze. VIMS will also conduct high resolution mapping for geology and composition starting at two hours after closest approach. New territory will be covered with this pass. Interestingly, the North pole observation is on Titan's dark side, to get a view of the large northern lake at dusk.

- **ISS** will observe the landing site at high resolution and take images to provide regional-scale stereo coverage with images from earlier T28 and T31 flybys. The T35 observations will include regional and global-scale mosaics, with the regional image centered on an interesting circular feature. The whole hemisphere is targetd by the global mosaic. ISS will have coverage of similar areas at lower resolution during the T36 flyby;. series of flybys that cover the same area repeatedly are useful for monitoring time dependent phenomena. These observations will allow us to see if, for instance, clouds are appearing or disappearing, if there are patterns in weather, or if the weather has any correlations with Titan surface features. Dwell (integration) times for these images are about 5-7 minutes long; longer images would be helpful, but would cut down on the amount of area that can be imaged during these opportunities.

- **CIRS** observations will emphasize increasing time coverage at lower resolutions where the instrument has already covered Titan's disk, and increasing spatial coverage for regions missed so far. The instrument will collect vertical temperature profiles in Titan's stratosphere, and vertical sounding of stratospheric compounds on Titan, including H2O. In addition, CIRS will often ride along with UVIS EUV/FUV scans. At this point in the mission CIRS surface coverage is quite good with respect to latitude, but longitudinal coverage for temperature variation still needs to be improved. Spatial coverage for Far IR composition integrations is quite good; better spatial resolution will be able to tie the CIRS temperature maps to albedo observations from ISS and altimetry data from RADAR.

- **UVIS:** The team will obtain spectral images of Titan in the EUV and FUV to map the aurora and dayglow, to map hydrocarbon absorption, and to measure scattering and absorption by aerosols in the stratosphere. Titan occults Sigma Sgr, and UVIS will use the observation opportunity for further atmospheric investigations.

- **RPWS** continues its definitive search for lightning in Titan's atmosphere and for radio emissions from Titan, along with investigating ion pickup processes and ionospheric plasma temperature and density. Interestingly, RPWS observations have found no evidence to date for radio emissions, and have not detected terrestrial-type lightning. Probe scientists have seen interesting signatures in their data that could be lightning, but RPWS data don't support that conclusion…at least, not yet.

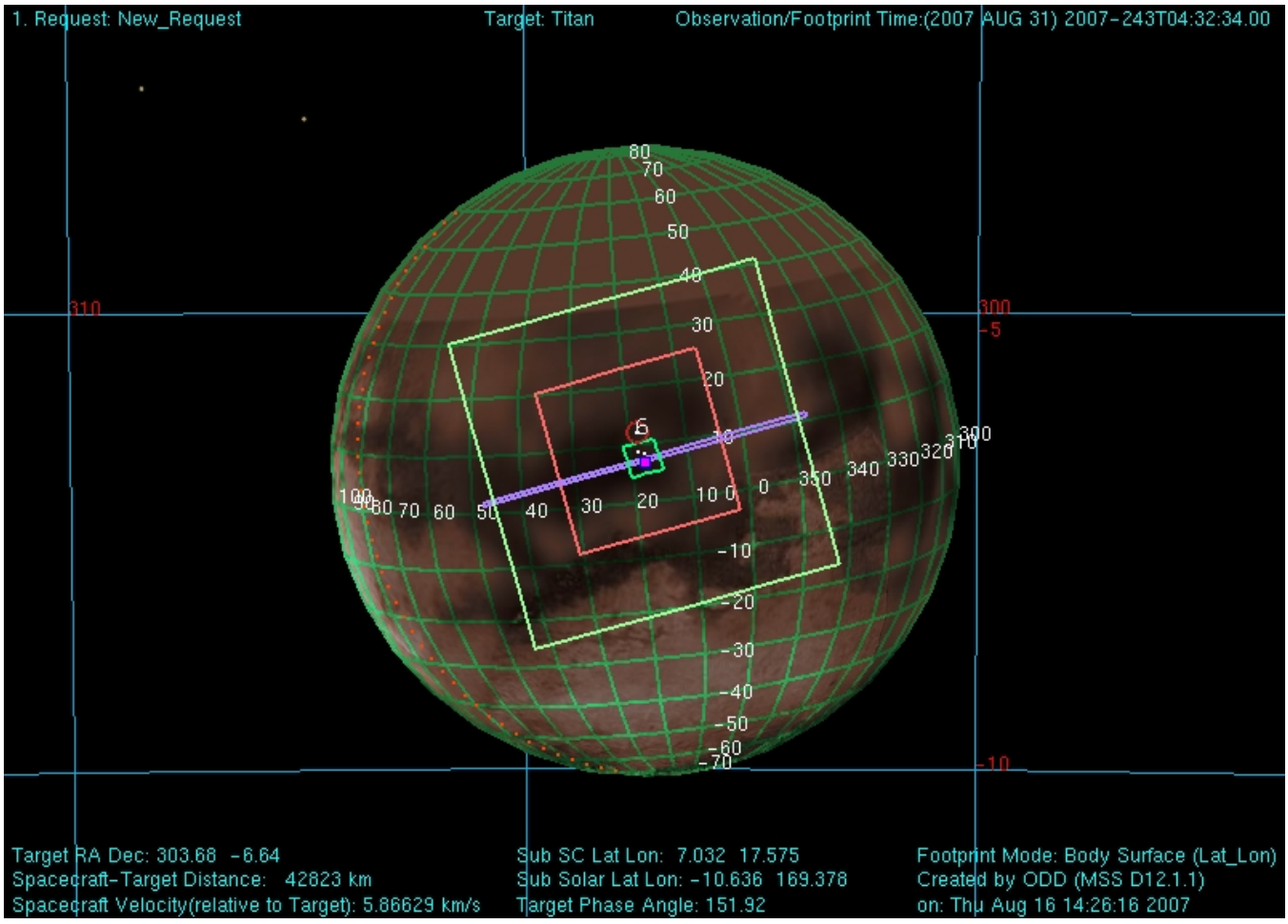
1.2 SAMPLE SNAPSHOTS

Three views of Titan from Cassini before, during, and after closest approach to Titan are shown below. The views are oriented such that the direction towards the top of the page is aligned with the Titan North Pole. The optical remote sensing instruments' fields of view are shown assuming they are pointed towards the center of Titan. The sizes of these fields of view vary as a function of the distance between Cassini and Titan. A key for use in identifying the remote sensing instruments fields of view in the figures is listed at the top of the next page.

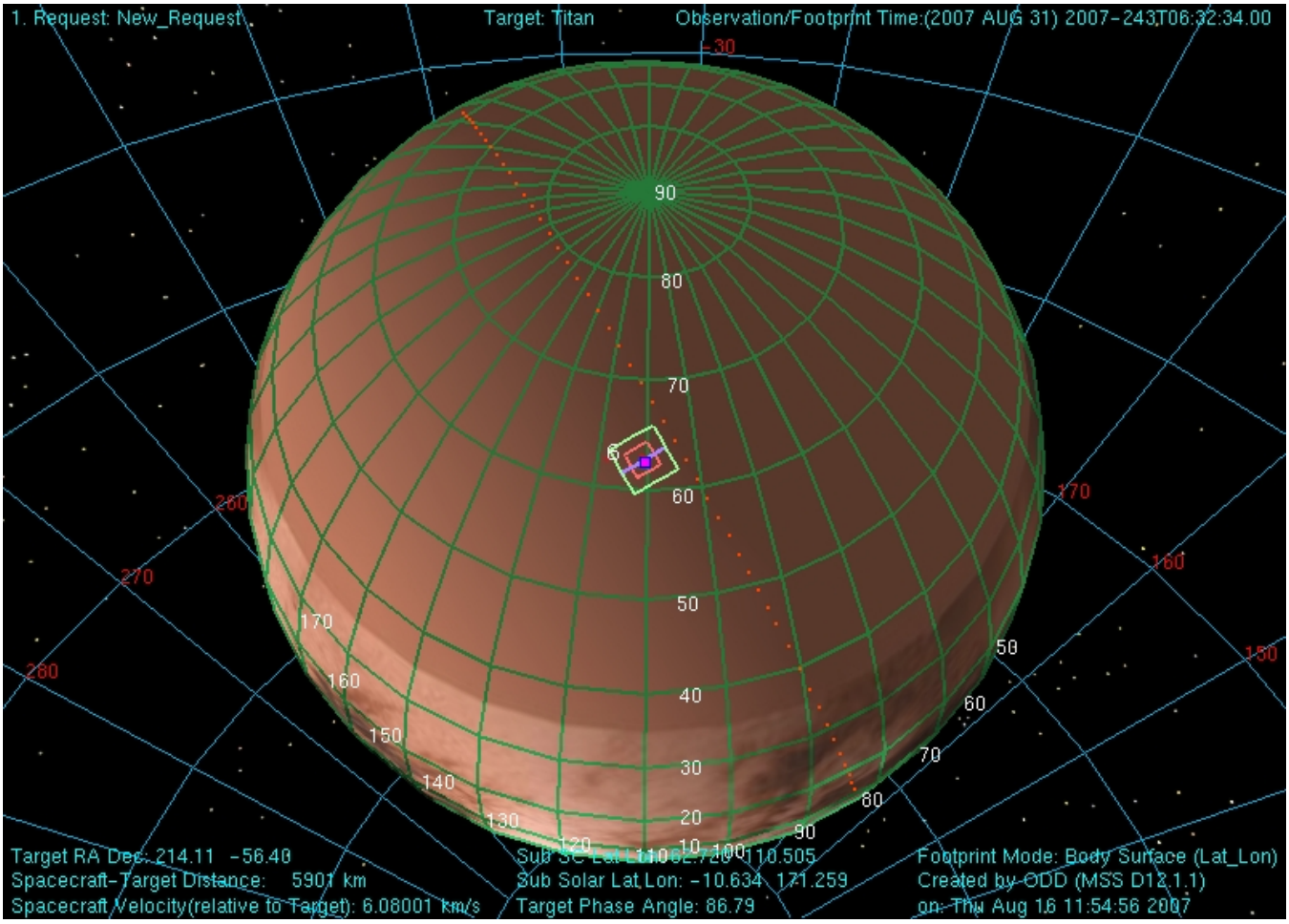
Key to ORS Instrument Fields of View in Figures

Instrument Field of View	Depiction in Figure
ISS WAC (imaging wide angle camera)	Largest square
VIMS (visual and infrared mapping spectrometer)	Next largest pink square
ISS NAC (imaging narrow angle camera)	Smallest green square
CIRS (composite infrared spectrometer) – Focal Plane 1	Small red circle near ISS_NAC FOV
UVIS (ultraviolet imaging spectrometer)	Vertical purple rectangle centered within largest square

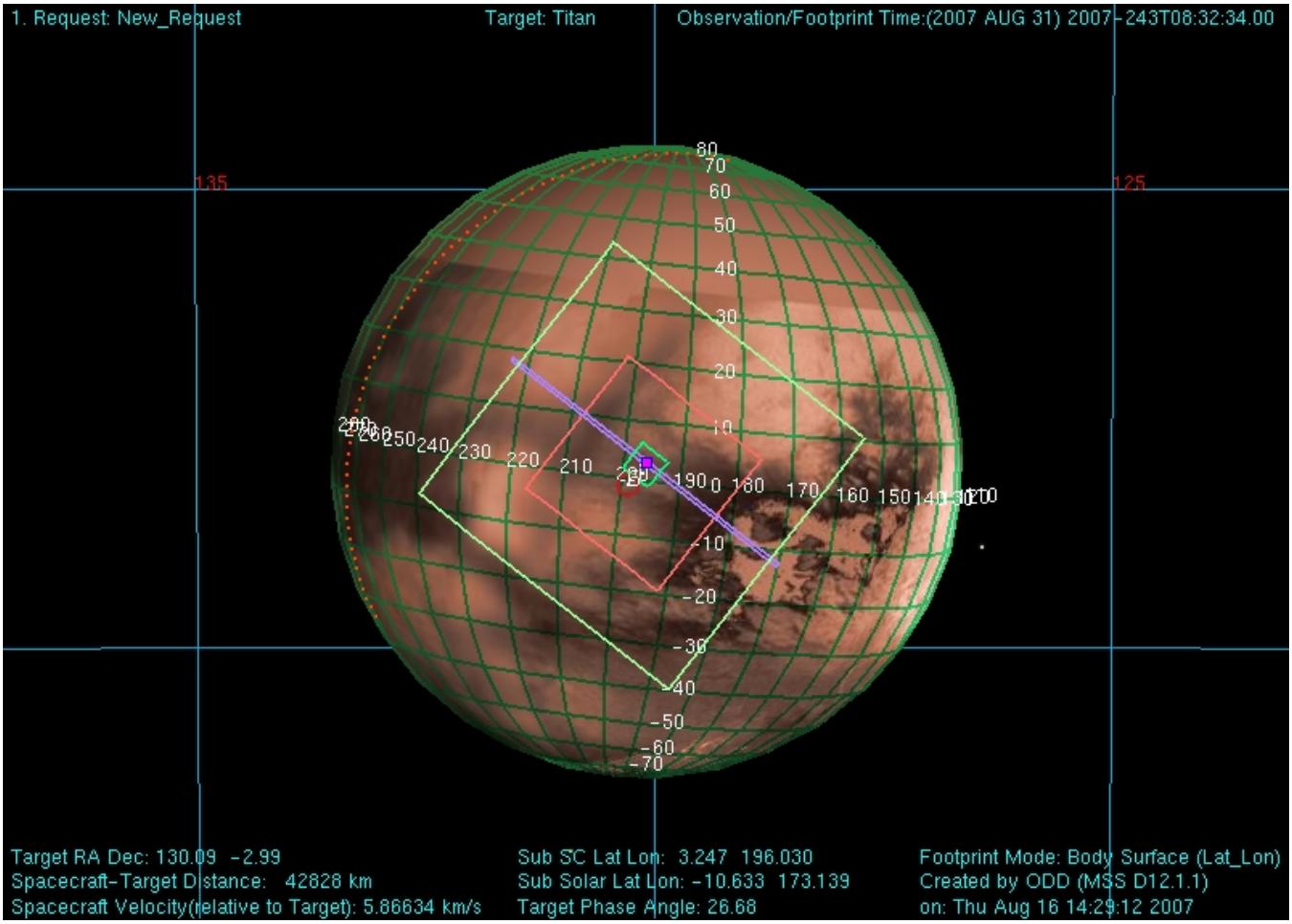
View of Titan from Cassini two hours before Titan-35 closest approach



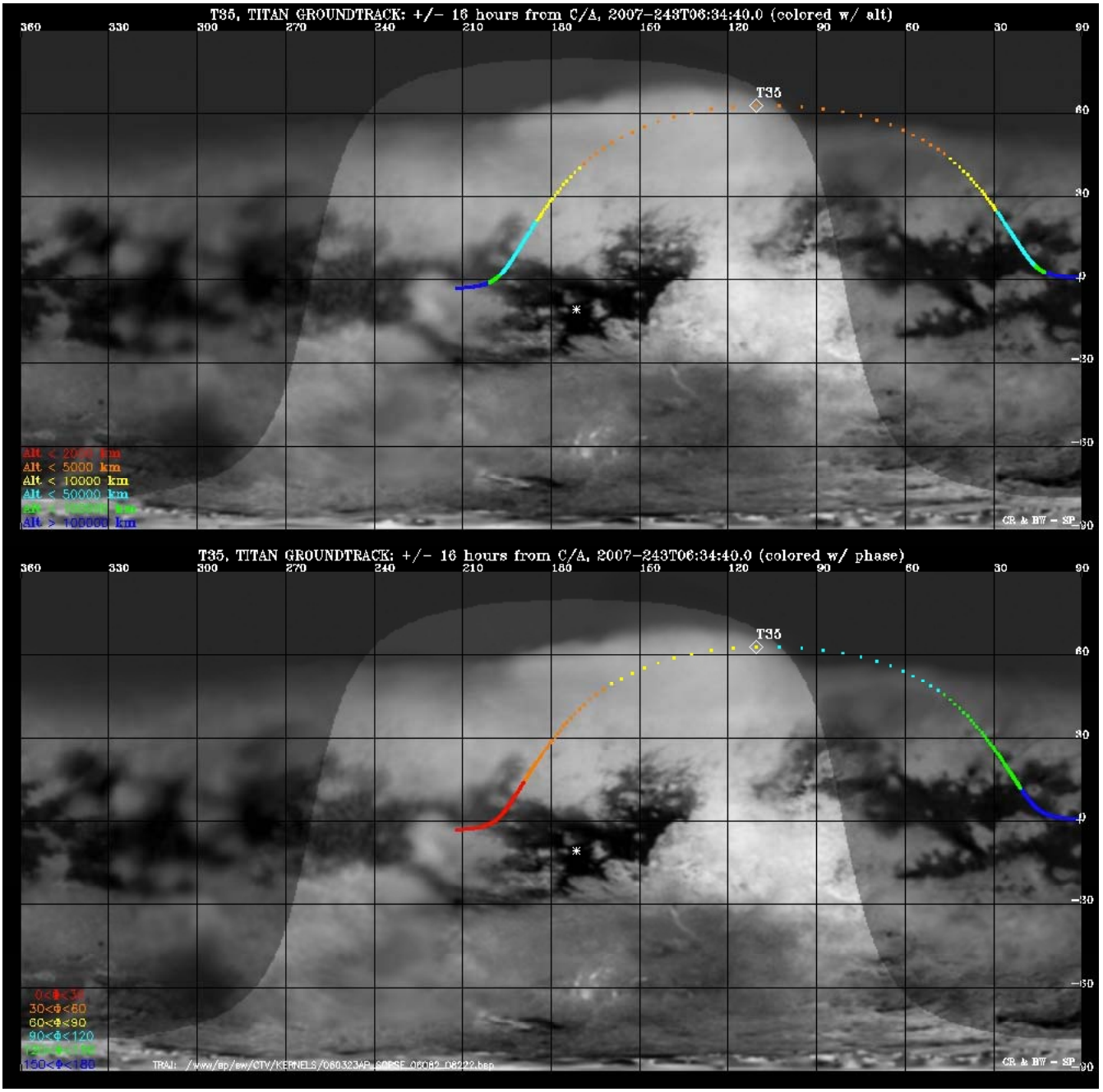
View of Titan from Cassini at Titan-35 closest approach



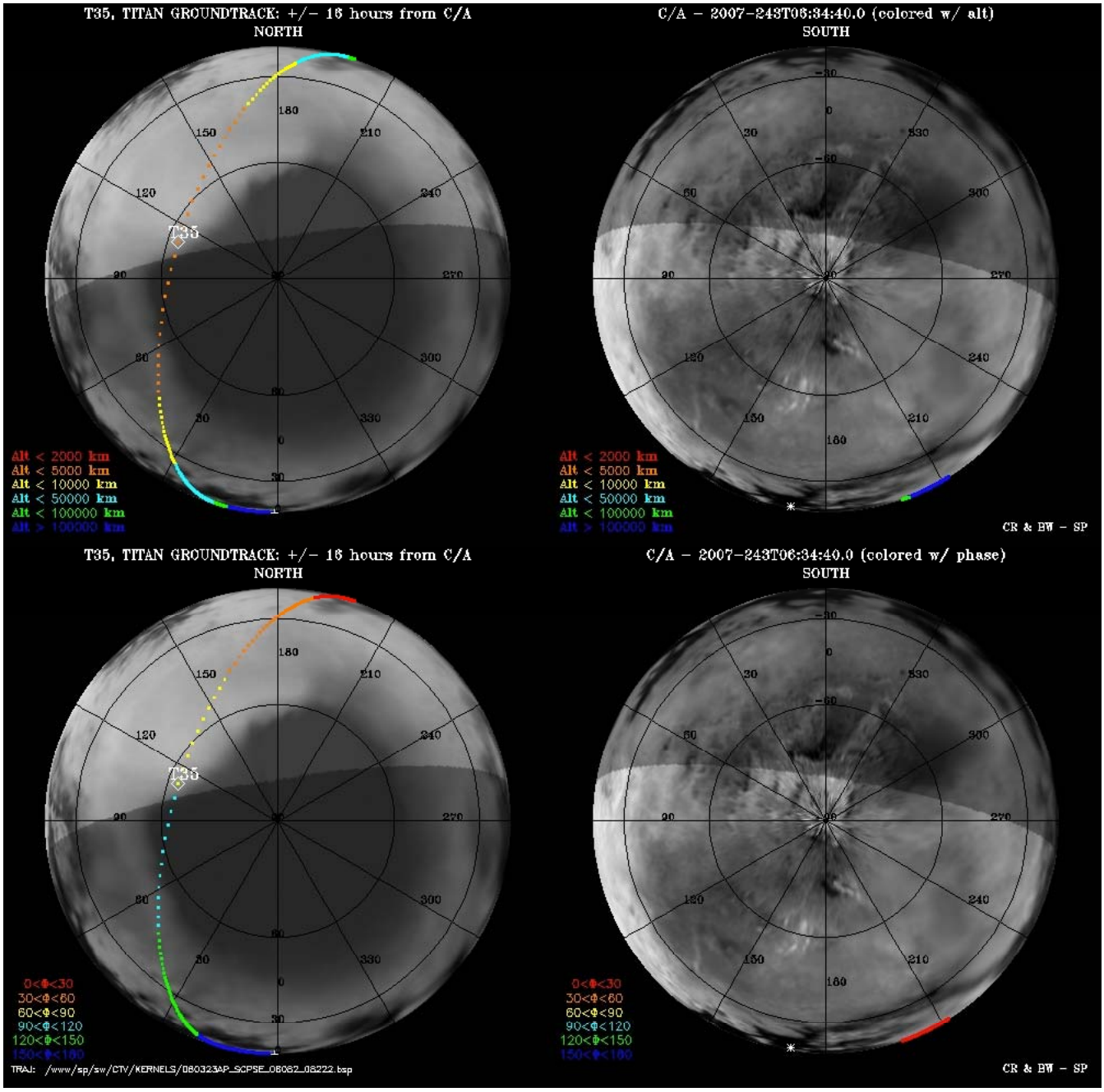
View of Titan from Cassini two hours after Titan-35 closest approach



Titan Groundtracks for T35: Global Plot



Titan Groundtracks for T35: Polar Plot



The T35 timeline is as follows:

Cassini Titan-35 Timeline - August 2007

Colors: yellow = maneuvers; blue = geometry; pink = T35-related; green = data playbacks

Orbiter UTC	Ground UTC	Pacific Time	Time wrt T35	Activity	Description
223T23:20:00	Aug 12 00:45	Sat Aug 11 04:45 PM	T35-19d07h	Start of Sequence S33	Start of Sequence which contains Titan-35
239T13:20:00	Aug 27 14:45	Mon Aug 27 06:45 AM	T35-03d17h	OTM #124 Prime	Titan-35 targeting maneuver.
240T13:20:00	Aug 28 14:45	Tue Aug 28 06:45 AM	T35-02d17h	OTM #124 Backup	
241T07:22:55	Aug 29 08:47	Wed Aug 29 12:47 AM	T35-01d23h	Descending Ring Plane Crossing	
241T13:02:32	Aug 29 14:27	Wed Aug 29 06:27 AM	T35-01d18h	Saturn Periapse	Saturn periapse, R = 5.4 Rs, lat = 0 deg, phase = 132 deg
242T17:34:00	Aug 30 18:59	Thu Aug 30 10:59 AM	T35-12h58m	Start of the TOST segment	
242T20:49:00	Aug 30 22:14	Thu Aug 30 02:14 PM	T35-09h43m	Turn cameras to Titan	
242T21:19:00	Aug 30 22:44	Thu Aug 30 02:44 PM	T35-09h13m	Deadtime	27 minutes 20 seconds long; used to accommodate changes in flyby time
242T21:32:34	Aug 30 22:57	Thu Aug 30 02:57 PM	T35-09h00m	Titan atmospheric Observations	Obtain vertical profiles of temperatures in Titan's stratosphere.
243T01:32:34	Aug 31 02:57	Thu Aug 30 06:57 PM	T35-05h00m	Titan atmospheric and surface observations	Obtain information on surface & tropopause temperatures, and on tropospheric CH4.
243T04:32:34	Aug 31 05:57	Thu Aug 30 09:57 PM	T35-02h00m	Titan atmospheric Observations	Obtain information on CO, HCN, CH4. Integrate on disk at airmass 1.5--2.0.
243T05:32:34	Aug 31 06:57	Thu Aug 30 10:57 PM	T35-01h00m	Titan atmospheric Observations	Temperature of the high atmosphere and vertical profiles of N, N2 and hydrocarbons at many latitudes
243T05:55:34	Aug 31 07:20	Thu Aug 30 11:20 PM	T35-00h37m	Titan surface observations	
243T06:32:34	**Aug 31 07:57**	**Thu Aug 30 11:57 PM**	**T35+00h00m**	**Titan-35 Flyby Closest Approach Time**	**Altitude = 3326 km (2066 miles), speed = 6.1 km/s (13,650 mph); 87 deg phase at closest approach**
243T06:32:34	Aug 31 07:57	Thu Aug 30 11:57 PM	T35+00h00m	Titan surface observations	high-resolution cubes of Titan's surface
243T08:32:34	Aug 31 09:57	Fri Aug 31 01:57 AM	T35+02h00m	Titan surface observations	Regional map
243T10:32:34	Aug 31 11:57	Fri Aug 31 03:57 AM	T35+04h00m	Titan atmospheric Observations	Obtain information on surface & tropopause temperatures, and on tropospheric CH4.
243T11:32:34	Aug 31 12:57	Fri Aug 31 04:57 AM	T35+05h00m	Titan surface observations	Global Map
243T15:08:34	Aug 31 16:33	Fri Aug 31 08:33 AM	T35+08h36m	Titan atmospheric Observations	particle properties, vertical distributions ~6 km/px.
243T15:32:34	Aug 31 16:57	Fri Aug 31 08:57 AM	T35+09h00m	Titan atmospheric Observations	Obtain information on CO, HCN, CH4. Integrate on disk at airmass 1.5--2.0.
243T21:32:34	Aug 31 22:57	Fri Aug 31 02:57 PM	T35+15h00m	Titan atmospheric Observations	Obtain information on the thermal structure of Titan's stratosphere.
244T03:32:34	Sep 01 04:57	Fri Aug 31 08:57 PM	T35+21h00m	Deadtime	17:26 long; used to accommodate changes in flyby time
244T04:20:00	Sep 01 05:45	Fri Aug 31 09:45 PM	T35+21h48m	Turn to Earth-line	
244T04:20:00	Sep 01 05:45	Fri Aug 31 09:45 PM	T35+21h48m	Playback of T35 Data	Madrid 34M and Goldstone 70M

The T35 playback timelines is as follows (following page):

T35 (49TI) Playback Timeline

Created Aug 14, 2007

Event or Observation	Observation Type (APGEN)	Observation Record Start Time (yyyy-dddThh:mm:ss) (SCET)	Record Start Time - Reference Epoch (hh:mm)	Start Playback (Ground UTC)		Start Playback (Pacific Time)	
				Best Estimate	Using Average Data Rates	Best Estimate	Using Average Data Rates
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VIMS_049TI_MIDIRLIMB001_CIRS	VIMS_18432	2007-242T21:32:34	-00T09:00	01-Sep Sat 06:24 AM	Sat 06:27 AM	31-Aug Fri 11:24 PM	Fri 11:27 PM
CIRS_049TI_FIRNADMAP001_PRIME	CIRS_4000	2007-243T01:32:34	-00T05:00	01-Sep Sat 09:55 AM	Sat 10:19 AM	01-Sep Sat 02:55 AM	Sat 03:19 AM
CIRS_049TI_FIRNADMAP001_SI	ISS_SUPPORT_IMAGIN(	2007-243T01:32:34	-00T05:00	01-Sep Sat 09:55 AM	Sat 10:19 AM	01-Sep Sat 02:55 AM	Sat 03:19 AM
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CDA_049OT_DRATE003_RIDER	CDA_524	2007-243T01:34:00	-00T04:59	01-Sep Sat 09:56 AM	Sat 10:21 AM	01-Sep Sat 02:56 AM	Sat 03:21 AM
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T35 (49TI) Playback Timeline

Created Aug 14, 2007

Event or Observation	Observation Type (APGEN)	Observation Record Start Time (yyyy-dddThh:mm:ss) (SCET)	Record Start Time - Reference Epoch (hh:mm)	Start Playback (Ground UTC)		Start Playback (Pacific Time)	
				Best Estimate	Using Average Data Rates	Best Estimate	Using Average Data Rates
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INMS_049SA_SURVEY004_RIDER	INMS_1498	2007-243T18:32:34	00T11:59	05-Sep Wed 09:26 PM	Thu 01:13 PM	05-Sep Wed 02:26 PM	Thu 06:13 AM
CIRS_049TI_MIDIRTMAP002_PRIME	CIRS_4000	2007-243T21:32:34	00T14:59	05-Sep Wed 09:42 PM	Thu 02:40 PM	05-Sep Wed 02:42 PM	Thu 07:40 AM
CIRS_049TI_MIDIRTMAP002_SI	ISS_SUPPORT_IMAGIN(	2007-243T21:32:34	00T14:59	05-Sep Wed 09:42 PM	Thu 02:40 PM	05-Sep Wed 02:42 PM	Thu 07:40 AM
ISS_049TI_MIDIRTMAP002_CIRS	ISS_Phot_1_by_1	2007-243T21:32:34	00T14:59	05-Sep Wed 09:42 PM	Thu 02:40 PM	05-Sep Wed 02:42 PM	Thu 07:40 AM
UVIS_049SW_IPHSURVEY025_RIDER	**UVIS_5032**	**2007-244T02:20:00**	**00T19:47**	**05-Sep Wed 10:03 PM**	**Sat 06:43 PM**	**05-Sep Wed 03:03 PM**	**Sat 11:43 AM**
CIRS_049IC_DSCAL07244_RIDER	CIRS_4000	2007-244T05:20:00	00T22:47	01-Sep Sat 05:26 PM	Sat 05:26 PM	01-Sep Sat 10:26 AM	Sat 10:26 AM
INMS_049SA_SURVEY005_RIDER	INMS_1498	2007-244T06:32:00	00T23:59	01-Sep Sat 05:32 PM	Sat 05:32 PM	01-Sep Sat 10:32 AM	Sat 10:32 AM
MIMI_049CO_SURVEY006_RIDER	MIMI_8000	2007-244T06:32:01	00T23:59	01-Sep Sat 05:32 PM	Sat 05:32 PM	01-Sep Sat 10:32 AM	Sat 10:32 AM